

Collaborative Construction of Task Activity: Coordinating Multiple Resources in a High School Physics Lab

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This article documents the collaborative coordination of multiple resources—talk, gesture, and writing—as represented in the interaction among 3 high school seniors working on a physics laboratory task. Through the close analysis of the moment-to-moment construction of task, this study draws attention to complex yet taken-for-granted practices that are integral to thinking and acting in the ubiquitous context of laboratory activities. In line with other research on situated action, it is critical to our understanding of jointly implemented activities that we look closely at their forms on particular occasions. These students display forms of competence that can be manifested only in interaction. From this perspective, learning activities

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involve not only making conceptual connections but also, and crucially, making interactional connections, knowing how to collaboratively construct a task.

This article documents the collaborative coordination of multiple resources—talk, gesture, gaze, and written materials—as represented in the interaction among three high school seniors as they work together on a physics laboratory task. Through the close analysis of the social construction of task, on a moment-to-moment basis, this study draws attention to the highly complex, yet taken-for-granted practices that are integral to thinking and acting in the context of laboratory activities. It is critical to our understanding of such jointly implemented activities, whether in the classroom or in the workplace, that we look carefully at the practices—shared and recurrent and yet locally contingent—through which tasks take form on particular occasions. In the case of this laboratory task, I show (a) that reading, both privately or aloud, and reference formulations are tightly tied to action structure; (b) that multiple resources, both immediate and generic, are deployed in constructing and maintaining the “jointness” of the activity; and (c) that there is special work required of students in order to both maintain their task focus and to display deference to the authority of their instructor.

The study of talk-in-interaction in institutional settings is a growing area of focus for scholars. Although an orientation to the joint accomplishment of tasks is commonplace, situations vary with respect to the particular resources that are jointly managed. The recent volume *Situated Order* (ten Have & Psathas, 1995) contains a number of studies illustrating ways in which talk and gesture—along with the resources and constraints of physical setting, objects, and standardized written materials (including computer programs)—are managed by task participants. Contributions on telephone survey interviews (Houtkoop-Steenstra, 1995) and on computer-aided dispatch in public safety communications (Whalen, 1995) demonstrate different ways that standard written formats associated with official interactions shape the talk of the participants and are, at the same time, creatively adapted to the exigencies of online interaction. In a study of collaborative construction in airport workplace settings, M. H. Goodwin (1995) documented the coordination of physical resources and spoken communication, along with the ways that the “predictable structure of work activity” (p. 185) allows coworkers to anticipate next actions and aid in their individual and joint tasks. As we will see in the current laboratory setting, writing, physical objects, familiar action trajectories,

and recurrent interactional structures are also jointly coordinated in the working through of a shared task.

Prior work in ethnomethodology (e.g., McDermott, 1976; Mehan, 1979) and interactional sociolinguistics (e.g., Cook-Gumperz, 1986; O'Conner & Michaels, 1996) has shed light on the discourse patterns characteristic of educational activities and the inequities that can result from a lack of fit between school, community, and home interactional styles. Thus, in addition to contributing to the study of multiple resources in institutional talk-in-interaction, this article presumes that understanding educational practice will be facilitated by observing skills and interactional strategies that students employ as they collaborate and make sense together in performing a laboratory task.

The data come from a physics course videotaped in the Spring of 1997 as part of a longitudinal study of socialization into subject matter courses at a high school in a major U.S. urban center. The class included both juniors and seniors and was judged by the high school faculty to be the most advanced science course offered that year. Highlighted in the segment of activity on which this article focuses are the students' skills at managing and manipulating physical objects, written materials, social roles, and their ongoing and orderly construction of a shared task. Also included is the interaction between these students and their instructor. The analysis of discourse as, and action during, this lab assignment provides one detailed perspective on the complex interactional abilities that are taken-for-granted components of such activities.

My intention, then, is to provide a fine-grained picture of the practices three students—Kira, Edith, and Delia (pseudonyms)—employ.¹ My focus is on the documentable skills they demonstrate as they work through a laboratory procedure. The simultaneous and highly interactional management of resources is a kind of literacy in action. Although these skills may not be those generally measured by standardized tests in educational systems, it is perhaps time that talk-in-interaction be included in our picture of what students know. An understanding of the interactional matrix of laboratory task action can provide a knowledge base to be tapped by educational practitioners as they strive to create and maintain supportive social contexts for learning.

The primary method I have used is conversation analysis (see Maynard & Clayman, 1991; Pomerantz & Fehr, 1997). I focus on the resources and practices of the participants in the interaction, as made accessible to me through repeated viewing and analysis of video recordings made from

two cameras. Hearable and visible actions are the primary local resources that the interactants deploy and interpret as they work together.²

THE LABORATORY TASK

In the portion of the laboratory task this article examines, Delia, Edith, and Kira are working on a physics assignment titled “The Image in a Plane Mirror.” Each student has two sheets for the laboratory (see Appendixes A & B); the details of these sheets, and the numbers on them, become important in the interaction. The first sheet, which is bright yellow, lists two procedures with Roman numerals “I” and “II,” one procedure on each side of the sheet. Procedure I is further divided into Arabic numerals 1 to 6, and Procedure II continues those numbers with 7 through 12. The second sheet, this one white, is for recording conclusions; it is divided into Arabic numerals 1 to 12.

At the point where this analysis begins, Delia, Kira, and Edith are working at a laboratory table. Delia is on one side, Kira and Edith on the other. Kira is seated, whereas Delia and Edith are both standing. The three have just finished the “Procedure: Part I” in the laboratory exercise (see Appendix A) using candles and small pane of glass to work with the perception and measurement of distance in reflected images. At this point, Delia and Edith are visibly occupied with writing (Figure 1). Two aquariums partially block the camera’s view of the surface of the laboratory table.

The practices that these students employ are quite complex, and their actions perform a number of interactional functions simultaneously. For the sake of exposition, however, I divide the discussion into separate themes, focusing on practices and functions that, in their actual performance, are overlapping. The first section highlights the relation between reading, reference, and action. The next one looks at the work the students do to constitute “jointness” of the group and to co-construct their framework of participation as jointly managed. The third section focuses on the way the orientation to a shared task becomes a resource in their social organization, and the fourth section looks at the interactional treatment of teacher talk and the concurrent construction of student roles. I conclude with a summary and a discussion of the importance of microanalysis of social and interactional skills associated with this kind of task.



FIGURE 1 Delia, Kira, and Edith writing.

READING, REFERENCE, AND ACTION

As the students begin Part II of the laboratory procedure, what we find is that literate action and talk-in-interaction are inseparable. The written materials, the generic shape of laboratory activities (learned over time), and the locally enacted spoken and gestural actions operate reflexively: the reading, talk, and gesture are each embedded in and dependent on the other. The students' actions are guided by the items on the procedure sheet, and these items are, in turn, associated with response items on the conclusion sheet (see Appendix B). Kira, Delia, and Edith jointly coordinate their interaction with the different sheets, with the other physical objects, and with each other, and this ongoing shared coordination invokes and maintains a group focus. There are, however, moments of individual reading and writing. Thus, when Kira is finished writing the conclusions to Procedure I (just prior to example [1], following), she waits while the others continue writing their conclusions.

As the others continue writing, Kira plays with the candle from Procedure I. Then, simultaneous with the teacher's approach (visible from the second camera), she picks up the yellow (Appendix A) procedure sheet and turns it over (Figure 2). Recall that Procedure II is on the second side of the sheet. After a quick look at the second side of the sheet, Kira produces the single word turn "Two."

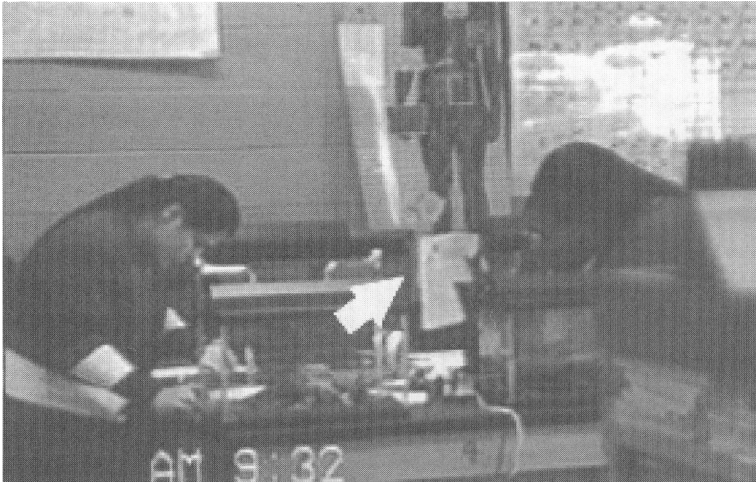


FIGURE 2 Kira lifting the yellow procedure sheet (arrow).

(1) *Kira lifts the yellow procedure sheet and flips it over in front of her* (Figure 2).

- ⇒ 1 K: Two. ((**holding yellow procedure sheet**))
 2 (0.7)
 3 D: So number one and two are the same.

Kira's "Two" is delivered clearly and loudly.

Interpreting the reference of Kira's "Two" provides us with an initial demonstration of the relation among reading, reference, task action, and talk that these students manage in their work together. There are three possible referents for "Two" on the sheets they are using: On the yellow procedure sheet (Appendix A), the students have just completed Roman numeral I (on the first side), which leads to conclusion Items 1 and 2 on the white conclusions sheet. However, Procedure I also contains steps numbered 1 to 6. Finally, there is the second procedure itself, Roman II. Thus, "Two" could potentially refer to Arabic 2 on *either* sheet as well as to Roman II on the procedures sheet.

Kira is currently holding the yellow procedures sheet, and this fact is visibly available to the participants when they look at her and possibly in their peripheral vision as they write. By manipulating the procedures sheet before and during her turn at line 1, Kira offers a context for interpreting her "Two" as "Procedure: II" rather than "Conclusion 2" (white conclusions sheet). Item 2 (Arabic) from the procedure sheet (first

side) would also be an unlikely interpretation; this is a step they have already completed, and Kira has just flipped the sheet over in front of her, a movement visible to the other participants.

Looked at in a slightly different way, Kira builds her task-oriented turn in a manner that is precisely coordinated with its place in the action. That is, in the context that her own nonverbal actions have created at this particular point in the shared task, the reference of Kira's single word turn, "Two," can be unequivocally interpreted by the other participants. Indeed, despite the multiple possible referents for "Two," neither Delia nor Edith treats Kira's turn as problematic.

A first observation can be made here regarding reading and interaction in a joint laboratory task such as this one; the inseparability of reading, speaking, and acting in the construction of this task provides an example of literacy in action. The laboratory task has an order that provides a constantly available resource that these students use as an interactively shared and anchoring reference and for bringing the attention of the group members together. As a resource for joint orientation, the order of the activity includes both the immediate written procedures and the recurrent shape of laboratory tasks in general. I explore the role of the shared task order later. What I highlight here is the interweaving of the written material and the spoken interaction.

The written material, in this case the procedure sheet, is not treated as a freestanding text, to be engaged with individually and for extended periods. Instead, the written material is used as an integral resource for the ongoing construction of the group's work. What Kira is doing with her announcement of "Two" involves use of the written material as an orienting and anchoring resource in the course of a joint activity. The yellow procedures sheet, which she is holding and gazing at, serves both as a source for reading aloud the number "Two," and as a physically contextualizing "prop" guiding her interlocutors to the reference for that number. In the context of the recurrent agenda of laboratory activity and in the context of the particular procedures the students are sharing on this occasion, Kira's uses her single-word turn, "Two," and her visible orientation to the second side of the procedures sheet to propose that the group move ahead with their activity. The joint construction of this moment in the laboratory activity is achieved through the interweaving of reading, speaking, and collaborative action.

Looking closely at Kira's proposal and Delia's responses to it gives us a further sense of the seamless connection between reading, reference,

and action for these students, and it also reveals the joint concern for a “one-step-at-a-time” organization.³ By reading aloud the number “Two,” Kira attempts to move the group into the next part of their joint activity.⁴ To constitute a joint activity, that is, for Kira to effectively bring the group together to mark the end of the last step and a move to the next, the other members must join in, they must align with Kira’s proposal through their responses. Evidence for Kira’s turn being taken as a proposal to move on, and thus a marker of being done with the previous step, can be found in Delia’s response, to which I now turn.

Because the other two participants have not been attending to Kira, one would expect a gaze shift from them and probably a response after Kira’s announcement (C. Goodwin, 1981). During the 0.7-sec pause after Kira’s “Two,” while Delia continues writing on the white conclusion sheet, she also gradually raises her head (see Figure 3). However, when Delia speaks, her turn is not occupied with a direct response to Kira’s turn (a direct response would affirm and continue the movement into Procedure II, which Delia’s turn at 3, in fact, delays); rather, her turn initiates an insertion sequence (Schegloff, 1972). Instead of aligning with Kira’s move into the next procedure, Delia offers a candidate conclusion for the items associated with Procedure I on the conclusion sheet (“So number one and two are the same.”). As described by Schiffrin (1987), “So” can be used to mark a next turn as introducing an inference drawn from the previous turn. When “So” is used in this way, “a respondent



FIGURE 3 Delia raising her head.

assigns to the initial speaker partial responsibility for the accuracy of his/her own inference” (p. 215). By introducing her turn with “So,” Delia proposes that she is offering an inference or conclusion that follows from the previous talk (or action). Delia thus initiates a new adjacency pair (turn plus fitted response; Schegloff & Sacks, 1973) rather than directly responding to Kira’s “Two.”

In her turn at line 3, Delia checks her understanding of what the answers to Items 1 and 2 on the white conclusions sheet should be, items that correspond to Procedure I (see Appendixes A and B), but Delia is not yet fully aligning with Kira’s proposal that they move on to Procedure II.

(2)

- 1 K: Two.
- 2 (0.7)
- ⇒ 3 D: So number one and two are the same.
- 4 (0.9)
- 5 K: Yeah.

In proposing this conclusion, Delia indexes the fact that she is still in the process of completing the conclusions to the previous procedure (what she has presumably been writing). With her turn at 3, Delia, now gazing at Kira, treats Kira as knowledgeable regarding the correct conclusions. This is a reasonable assumption on the part of Delia because Kira has just shown her readiness to move to Procedure II and has thus treated the previous procedure as indeed concluded. Delia, however, is displaying an orientation to a one-step-at-a-time principle; subtask completion must be achieved before they jointly move to a next ordered subtask.

However, note that the issue of interpreting number reference arises once more. How is it that Kira is to understand that Delia’s “two” is not the same object as Kira’s own “Two”? Why, for example, does Kira simply respond with “Yeah” (line 5), rather than “No. Procedure two is *not* the same as one,” or even “Which *two* are you talking about?” Neither Kira’s “Two” (line 1) nor Delia’s “two” (line 3) is treated as ambiguous or difficult to interpret. Once again, it is the shared context of materials and agenda, the moment of interaction in which Delia constructs her turn, that renders the referent straightforward rather than problematic. Delia’s visible reference to the white conclusion sheet, the sheet on which she is writing, provides an unequivocal anchor for her number reference in her turn at line 3. “Two” spoken by a participant who is working from

a white sheet (i.e., Delia), the only sheet on which the students are to write, is clearly distinct from “Two” uttered by a participant working from a yellow sheet (i.e., Kira). As was true with Kira’s “Two,” Delia’s “two” is contextualized with reference to the written material, and both the written material and the spoken number serve as anchoring resources for reference interpretation as well as action coordination.⁵

To summarize, a crucial cognitive and interactional challenge for members of this laboratory group involves coordinating the joint focus of the members as they move through the shared task. One practice Kira and Delia use for achieving this coordination involves manipulation of and reference to the mutually available written materials in the dynamic context of the ordered laboratory activity, a coordination I call *literacy in action*. The written materials themselves provide a context for interpreting a potentially ambiguous reference. Both the written materials and the recurrent orientation to ordered task activity associated with laboratory work (discussed following) are incorporated into the construction of this interactional moment. Thus, written materials and the recurrent character of task activities become resources for performing particular actions, and they also serve reflexively as contexts for the interpretation of actions.

CONSTITUTING JOINTNESS

Much work on classroom discourse has pointed to the particular and sometimes culture-specific practice of asking so-called “display” (Mehan, 1978; Wells, 1986) or “exam” questions (Searle, 1969),⁶ questions for which the “questioner has the information being requested” (Heath, 1983, p. 250). In the science laboratory interaction, questions for which the participants already have access to answers are regularly used. Such questions (and other actions formed into turns) *could* be dealt with individually and independently, but we find them used as key resources for constituting the “jointness” of the group’s activity.

Delia produces such a question as the interaction progresses (example 3). Kira has responded to Delia’s candidate conclusions (line 3, “So number one and two are the same”) with “Yeah” (line 5). Kira’s turn at line 5 economically addresses both aspects of Delia’s turn discussed previously: Kira’s “Yeah” confirms that she is finished with her conclusions and also that Delia’s answers match her own. It is only after this inserted adjacency pair, made up of Delia’s check and Kira’s confirmation,

that Delia proceeds to align herself (line 7) with Kira's previous move to begin the next procedure ("Two" at line 1).

(3)

1	K:	Two.	<i>move to procedure II</i>
2		(0.7)	
3	D:	So number one and two are the same.	
4		(0.9)	<i>inserted</i>
5	K:	Yeah.	<i>adjacency pair</i>
6		(1.1)	
7	D:	Which mirror are we supposed	<i>a next move into procedure II</i>
8	T:	->What you <u>try</u> to do as you go through the	
9		mazes is<	

These utterances not only work to convey information but they make visible and sharable particular steps in the task. In line 7, Delia aligns herself with Kira's move by providing a next question, focusing on an object necessary in order to do Procedure II ("Which mirror are we supposed"). Whereas the previous procedure involved candles and a piece of glass, Procedure II requires that each student hold a mirror. In Delia's turn at line 7, which is overlapped by the teacher's talk, she begins to ask a question that is thus specifically responsive to Kira's announcement "Two." The question Delia initiates with "Which mirror are we supposed" represents a coordinated next turn in a sequence of actions that move the group into the next procedure.

Note also that Kira's "Two" and Delia's second question about the mirror (line 7) both focus on information that is accessible to each of the students on her own: "Procedure: Part II" is printed boldly on side two of the procedure sheet, and the first item under II reads "Obtain a plane (flat) mirror." Each girl has a copy of the sheet, so there is no strictly information-based need for Kira to read the numeral aloud nor for Delia to request which mirror they will need; the students could each read about the task privately. Instead, in this instance and elsewhere in their interaction, these students use reading aloud and asking questions about the procedure (questions whose answers are individually accessible) as means of forming and maintaining an orientation to the achieved jointness of their laboratory activity. Kira's reading aloud of the number 2 and Delia's question "Which mirror are we supposed," are performed as parts of a concerted coordination of the problem-solving activity they are collaboratively constructing. These moves reference and reassert a focused

participation framework (Goffman, 1981; M. H. Goodwin, 1990),⁷ reconstituting the participants as working together after a moment of privately writing the conclusions to the previous procedure.

As they move into the next step, the students continue to use the strategies of reading aloud from the sheets and asking questions that are answerable through the individually available written material. Both practices function to propose next actions for the group and to provide opportunities for feedback on their shared focus of attention.

Another example of reading aloud to guide joint focus occurs a few moments later. After the interruption by the instructor (discussed later), Delia refocuses the group by reading aloud the first step of Procedure II. The procedure sheet is lying on the table, and Delia is free to simultaneously read the sheet, manipulate the mirror with her right hand, and move her left hand to her ear:

(4) At the series of dots, Kira quickly picks up the mirror with her left hand and moves her right hand to her right ear. "X" marks point at which Kira's hand reaches her ear.

D: Okay, (0.4) It says obtain a plane mirror, (.) and touch=

K: x

D: = your right ear, (1.0) as you are looking into it.

(5.6)

As Delia begins to read aloud "obtain a plane mirror," but before she produces "touch your right ear," Kira quickly picks up a mirror and puts her hand to her ear, her hand reaching her ear just as Delia produces the word "and." Given that Kira touches her ear before Delia voices that part of the directions, it is clear that Kira has already read the directions privately. The speed with which Kira does this action allows her to achieve a synchrony with Delia's guiding turn. Delia's turn functions as a hearably unfolding template, with respect to which the students can achieve jointness in their actions. Note also that it is only after Delia produces "touch your right ear" that she also brings her hand to her ear and looks in the mirror. She then completes reading aloud the first sentence of Procedure II, "as you are looking into it." By the time Delia completes this sentence, Kira has performed the hand to ear movement two times, and, during the 5.6 sec pause that follows, both Kira and Delia continue looking into their mirrors, touching their right ears, and looking back at the procedure sheet.

Again, as in lines 1 and 3 of example (3), the students use talk, in this case directions read aloud, as a guide for coordinating their actions and constituting themselves as engaged in a shared activity. Whether reading directions aloud or asking questions for which answers are individually available, these students use practices of giving voice to known and/or independently available information as a method for constituting themselves as a group in joint action.

Later in the laboratory session, all three students lean over their white sheets and write their individual responses to conclusions 3 and 4. Delia is the first of the three to look up again. She reads the next step aloud (this time from the white sheet):

(5)

1 D: Write the word mirror, as it appears in the mirror.

2 (4.8)

3 D: Actually it'll be backwards.

4 (5.4)

5 D: °Write the word mirror as it appears in the mirror.°

Delia's reading aloud of the next step is a vocal action proposing that they now move to the next item in the laboratory activity. Her reading aloud works to bring together her actions and those of the other group members (a move reminiscent of Kira's "Two" in example [1]). During and after Delia produces her turns at lines 1 and 3, the students glance at one another and shift positions in their chairs; Kira picks up a lab sheet, and Delia takes a seat for the first time.

Interestingly, Delia voices the directions two times, to potentially different ends. In contrast with the group guiding function of the first reading (line 1), which Delia produces loudly while she is still in an upright position, the repetition (line 5) is provided when she is seated and leaning over the sheet of paper. Not only has she shifted to this more private posture, but her repeat of the directions is also produced at a lowered amplitude. Both of these changes seem to index her move to an individual engagement with the writing task. Repeating the turn in this way, Delia makes it hearable and visible to the others that she is continuing to focus on this step of the task; she displays that she is in the midst of working it through.

What we observe, then, is that these students put concerted effort into visibly and hearably marking where they are in a task and when they are ready to move on. They use the resource of giving voice to shared

or accessible knowledge as a means of enacting the achieved jointness of their actions. As we will see, signaling where one is in the shared task order seems to be a central practice in the constitution of the joint activity of these students. Without this feedback from one another, the members of the group would lack essential guideposts for offering or eliciting help or for confirming a conclusion and moving forward.

COLLABORATIVE CONSTRUCTION OF TASK ORDER

Although it is clear that the procedure sheet itself offers one immediate organization for the group task, the use of the written procedure is not a given but rather an achievement based on interaction between students. When Kira quickly picks up the mirror and touches her ear, bringing her actions in line with what Delia is reading aloud, she is actively orienting to the understood goal of doing this task jointly (excerpt [4] earlier). In addition, the students show expectations that are not explicitly guided by the written materials. Their joint orientation to specific, but not explicit, components of a laboratory activity points to another level of shared “text” that is invoked as an interactional resource. These students have encountered and enacted such activities during previous class meetings in this course and very likely in previous science courses as well. The pattern of first reading the directions (privately and then aloud), then performing a step in the guided activity, and finally arriving at a discovery based on that step is a recurrent and recognizable action sequence for these students; they display a recognition of these sequentially ordered action components associated with laboratory work in a science class. The sequence can be provisionally schematized in Figure 4. Not only do the students produce these components of the activity, but evidence of this shared orderliness also emerges when an expected component does not occur; in such cases, the students express frustration and they work toward remediation. Furthermore, when a participant does not follow the



FIGURE 4 Lab action sequence.

implicit but understood order, she is censured. Such responses attest to the recognition by these participants of an organized sequence of talk and action in such academic tasks.

In the activity we are examining, the students first read the directions privately; as we will see is the case with Edith, they can be taken to task if they have not done this. Sharing the directions is both accompanied and followed by the performance of the directed action. At this particular point, performing the action involves observing, in a mirror, the movement of one's right hand to one's right ear. As Delia reads the directions, she and Kira both perform the action; they continue repeating the action during the silence that follows. What they treat as the expected next component is some form of discovery, an outcome or upshot based on the directed action. This expectation is made evident by the fact that, in this case, the discovery component seems to be problematically lacking—and this leads to a set of reactions. In fact, it is precisely the *lack* of a discovery that creates a situation where the students draw attention to the implicit shared expectation of this discovery component.

After performing the action of touching their ears and looking into their mirrors, both Kira and Delia index, through their talk and physical actions, the fact that no discovery has been made and that this situation is understood to be a problem. Instead of seeing something new in their mirrors, what they see is the obvious and normal: They put their right hands to their ears and they see what, in their nonscience lives, they understand and perceive as their right hands going to their ears. After several repetitions of the movement, Kira produces a frustrated report of her “nondiscovery” (lines 4–7):

(6)

- 1 D: Okay, (0.4) It says obtain a plane mirror, (.) and touch
- 2 your right ear, (1.0) as you are looking into it.
- 3 (5.6)
- 4 K: ↑It look like you're touching my: fay↑ ((D gazes at K))
- 5 It looks like I'm touching my right ↑ea:r.↓
- 6 (.)
- 7 K: ↑in the mirror↑?
- 8 (3.2) ((D repeats hand to ear movement))
- 9 D: Wait.
- 10 (0.5)
- 11 D: If I go like that, (1.1) ((D repeats hand to ear movement))

Through a variety of means, Kira's turn (lines 4–7) proposes that what she sees is just what one would expect. In her manner of producing this turn—high pitch, high amplitude, repeated lateral head shake, and hand held out toward Delia, palm up—Kira voices and embodies frustration at the fact that there is nothing unexpected. Delia gazes toward Kira as Kira produces her turn in lines 4–7, but rather than offering a verbal response, Delia looks back in her mirror and moves her hand to her ear another time (during the 3.2 sec pause at line 8; see Figure 5). Through Kira's turn at lines 4–7 and in Delia's repeat of the action, both students treat the sequence of action plus discovery/observation as relevant and, in this instance, they treat the discovery component as problematically absent.

Delia's redoing of the action is a response to Kira's observation of her nondiscovery (lines 4–7). In responding by redoing the action, Delia further acknowledges that they have not yet made the right new observation. Furthermore, when Delia says "Wait" (line 9), this command marks a suspension of progress in the activity. "Wait" proposes placing task progress on hold until the discovery can be reached, and it strongly draws attention to Delia's role in working toward the discovery (unlike Delia's low amplitude turn, example [5], line 5, which marks lack of progress but does not draw marked attention). Delia then proceeds to narrate her own further repetition of the hand to ear action with a conditional construction, "If I go like that," while Kira also repeats the hand to ear movement.⁸



FIGURE 5 Delia redoes the hand-to-ear action.

The actions of Kira and Delia—Kira’s high-pitched turn (lines 4–7) and Delia’s response of action repetition followed by her command and narrated repetition—evoke, constitute, and make reference to an implicitly shared task organization. These actions, verbal and nonverbal, are significant in that they display an orientation to an expected orderly sequence of action, the key sequential components they associate with the laboratory activity. The expected sequence includes a directed action followed by a new discovery. These students not only know how to use written directions as a resource for guiding their group actions and constituting their jointness, they also show a tacit recognition of, and an active orientation to, the more generic components of laboratory activities. In orienting to this shared order, the students perform another type of literacy in action, but here the shared text is not the written one alone, it is also the generic structure of laboratory activities. For these students, progress—movement forward in the laboratory activity—is not to be made until the discovery component of the task is produced.

As noted earlier, another function of interaction essential to this laboratory activity involves a continuous use of opportunities to refer to, to make hearable and visible, a shared sense of what is being accomplished at any particular moment in the activity. When Kira produces her high-pitched observation of the obvious, “It looks like I’m touching my right ear,” she publicly marks, for both herself and Delia, where they are as a group in the laboratory agenda (she also marks this for Edith, but that is another issue, see the following). Delia’s subsequent repetition of the action and her next two verbal contributions (lines 9 and 11) make visible that she is acting in line with Kira in their shared struggle to arrive at a discovery. At this point, however, their progress is blocked by another source: They are interrupted by Edith. The interaction that takes place with Edith offers a further perspective on what these students treat as expected in the coordination of the laboratory group activity. It also reinforces that these students value a one-step-at-a-time progression through the laboratory task.

What has Edith been doing while Kira and Delia moved into Procedure II? Mr. Jensen’s turn (shown in the following example [7], lines 8–11) provides us with an answer to this question. After watching Edith for a moment, Mr. Jensen makes reference to what she is doing, “the mazes.” Edith has, in fact, jumped ahead to the last task under Procedure II (see Appendix A, second side, Procedure II, Item 12). This step is extra, and the teacher has emphasized during his introduction to the

laboratory activity this day that the mazes are for “fun” and will not be turned in for credit. In order to see how Edith’s talk relates to what Kira and Delia have been doing and to the shared task order, we need to look back at the larger context, which I reproduce here:

(7)

- 1 K: Two.
 2 (0.7)
 3 D: So number one and two are the same.
 4 (0.9)
 5 K: Yeah.
 6 (1.1)
 7 D: Which mirror are we supposed
 8 T: [>What you try to do as you go into the mazes is<
 9 go as fast as you can. And then try to do it (.) a second
 10 (and) third time and see if it can go faster even yet.
 11 It’s kind of fun.
 12 (.)
 13 T: [(Twelve)
 14 K: [>(But) we’re not_]< finished? ((K gazes toward T))
 15 (0.7)
 16 K: That’s (0.6) after. ((K gazes toward E; nods toward E’s paper))
 17 (2.2)
 18 D: shhsss ((smiling outbreath))
 19 (0.3)
 20 D: Okay, (0.4) It says obtain a plane mirror, (.) and touch
 21 your right ear, (1.0) as you are looking into it.
 22 (5.6)
 23 K: ↑It look like you’re touching my: fay- It looks like
 24 I’m touching my right ↑ear:↑
 25 (.)
 26 K: ↑in the mirror↑?
 27 (3.2)
 28 D: Wait. (0.5) If I go like that, (1.1)
 29 E: °Okay what- >what am I suppose t- What are we supposed
 30 to do.<°
 31 K: READ. ((K gestures with hand toward E’s procedure sheet))
 32 (0.3)
 33 E: Where are we.

- 34 (0.7)
 35 K: Seven. ((K points to spot on E's procedure sheet))
 36 (0.3)
 37 D: But luh- look if I touch my right ear,
 38 K: it look like (-) (it's) me:
 39 D: [it's really my left, (0.2) in the
 40 mirror.
 41 (1.6)

Edith is treated as out of step with the group sequence at two points in this span of talk: at lines 16 and 31. At lines 8–11, the teacher addresses the group with a contribution based on his observation of what Edith is doing, that is, one of the mazes. Mr. Jensen reasonably assumes that what he sees Edith doing is what the group as a whole is doing. This is another manifestation of the expected jointness of the activity; in this case it is the teacher who expects that all members are the at the same point. However, as Kira points out (line 14), they are “finished.” Kira produces “we’re not finished” (line 14) while looking toward the teacher, who is, by this point, moving away. Yet Kira’s turn at line 16 is directed toward Edith. As she says “That’s after,” Kira nods toward Edith’s paper and looks at Edith. Kira then returns to a forward facing position, ready to continue what she has started with Delia (i.e., Procedure II). By characterizing what Edith is doing as a step that they will come to “after,” Kira treats Edith as out of synchrony with the group activity. The jointly constructed order of action is once again invoked with reference to a lack—here a lack of adherence to the shared, step-by-step sequence.

From lines 20 through 28, Kira and Delia continue with Procedure II, but we see in line 29 that Edith has still not joined them. She continues to be out of step and now explicitly asks what they are doing; “what am I suppose t- What are we supposed to do.” Her formulation of this question is interesting. Edith begins by using the first person singular pronoun but quickly restarts and repairs her turn using “we.” Her repaired formulation moves closer to a treatment of the activity as joint rather than individual. Nevertheless, Kira rapidly responds by drawing sharp attention to the fact that Edith is still out of synchrony. Edith is held accountable to the shared generic order which, as we have noted, involves a sequence of reading privately, reading aloud, acting, and discovering. Kira and Delia have already moved through several components of the activity with respect to Item 1, Procedure II. They have done private reading, shared the

directions aloud, and have already produced the directed action. In contrast, Edith has not even caught up with the individual reading. Kira reacts to Edith's question with a short, very loud, emphatic, and irritated sounding command, "READ." Kira becomes only slightly more helpful in her next turn, responding to Edith's "Where are we" with "Seven," accompanied by a gesture toward Edith's paper.

What we find in this interaction is that doing group work requires a concerted synchrony of talk and action on a backdrop of an implicitly shared but locally invoked organization of activities. On the positive side, this is enacted through the smoothly synchronized talk and action of Kira and Delia. The shared understanding of the order of action is also shown by the manner in which the lack of one component, the new discovery, is treated as problematic through Kira's high pitched, frustrated observation of the obvious (observing a normal mirror image where the new discovery component should be). The recognized need to move ahead only after a discovery is reached is also oriented to by Delia's marking of nonprogress with the command "Wait," followed by a narrated repetition of the action. On the more negative side, the recognized need for working in synchrony on a shared activity sequence is made visible and hearable at points where Edith is treated as out of synchrony with the joint order that Delia and Edith are enacting.

The shared abstract "text," the generic laboratory activity sequence, is oriented to by these students through a display of frustration and a call for suspension of progress when a component in the sequence is not emergent. Laboratory group members also show their orientation to the shared organization of actions when one of the group members is censured for being out of the jointly constructed order.

TEACHER TALK AND STUDENT ROLES

In addition to providing perspectives on literate action, interactive resources for the coconstruction of jointness, and the invoking of a shared template of action, the constructed order in this laboratory activity also offers a sample of the ways that the teacher presents himself, how the students collaboratively construct his status, and how each student asserts her own identity and competence. The teacher's talk is clearly privileged

Jensen is referring to mazes (“What you try to do as you go into the mazes”), and Delia and Kira are not working on mazes, Delia has to look beyond the talk and action that she has been engaged in with Kira in order to make sense of what Jensen is saying. If she assumes that Mr. Jensen is responding to the group, as he seems to be, then his reference to the mazes can only implicate Edith and what she is working on.

The exact point at which Delia turns her head toward Mr. Jensen coincides with the completion of the first problematic reference he produces. Delia turns toward him right after he produces the word “mazes.” Until that place in his turn, he could have been referring to Procedure II, but the word “mazes” has no connection to that procedure (involving mirrors and hand movements). In addition, Mr. Jensen is most likely looking at Edith’s paper during some portion of his turn, although his back is to both cameras, so there is no direct evidence for this. Delia’s first responsive action is to look toward Mr. Jensen, and this would allow her to trace the direction of his gaze (C. Goodwin, 1981).

In abandoning her own talk and making this rapid and visible shift in her attention, Delia collaborates with Mr. Jensen in transforming the participation framework from one in which the group members are guiding the action internally to a temporary framework in which they are active recipients of guidance from the teacher. In this moment of interaction, then, we observe Mr. Jensen and Delia collaboratively constructing his talk as privileged. Mr. Jensen’s turn overrides other action both in his production of the turn (overlap, with prior speaker dropping out) and in the responsive and coordinated transformation of the participation framework, which shifts within a split second from a group-centered to teacher-centered configuration.

A few moments later, after the students have reconstituted a structure of participation in which they are again guiding their actions internally, the teacher intervenes again (excerpt [9] lines 4–5). Delia is just beginning to verbalize the “discovery” that she and Kira had been searching for (discussed in the previous section):

(9)

- 1 D: If I touch my right e:ar, (0.4) I’m really like this,
- 2 (.) So I’m touchin’ my left ear.
- 3 (.)
- 4 T: And the reason >that the< person is looking, (.) You’re
- 5 looking at uh(.)Kira, (.) (‘cause) she’s like an image.

As Delia says “I’m really like this,” she turns around completely so that she is now facing the opposite direction, away from the laboratory table (Figure 6). In so doing, she places herself where her mirror had been. She also switches to touching her left ear with her left hand. Through these movements, Delia enacts and embodies the discovery that the mirror image shows the reverse of the object being reflected. It is at this point that the teacher adds an explanation of the discovery. By using the connector “And,” Mr. Jensen formats his contribution as an extension of

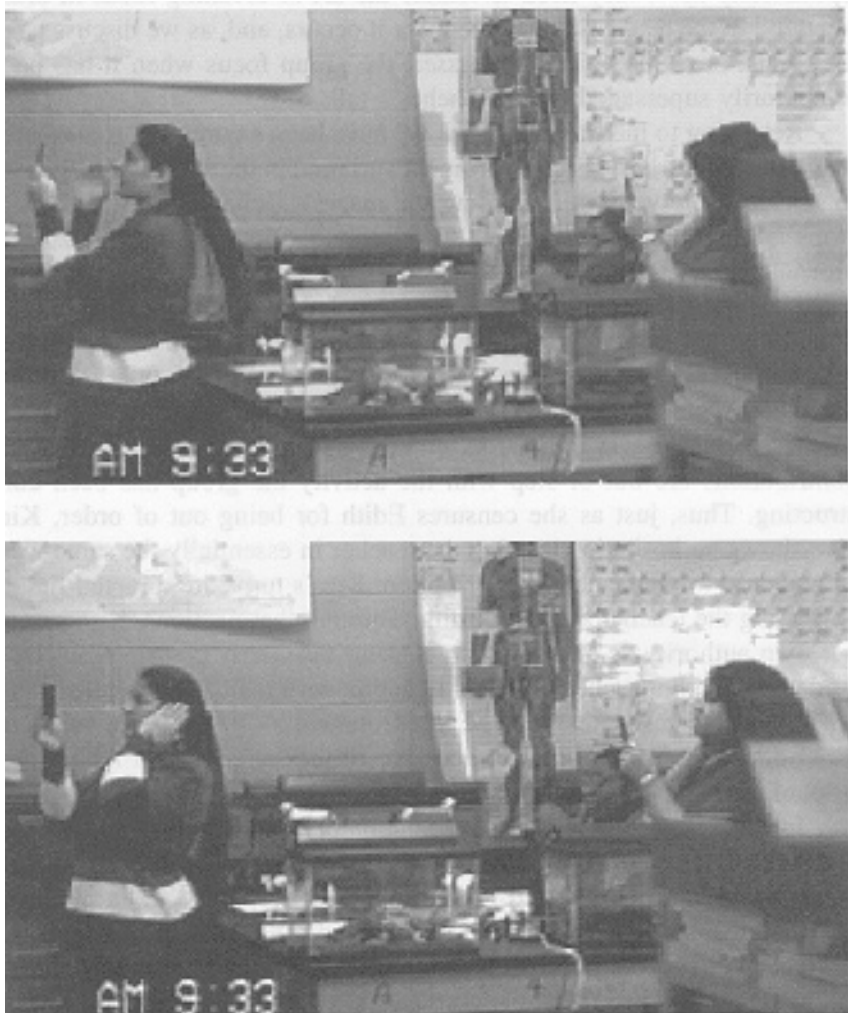


FIGURE 6 Delia turns around and embodies her mirror image.

Delia's talk. The teacher's addition is presented as one that is integrally connected to the group's work. In collaboratively extending Delia's talk, Mr. Jensen again demonstrates that he is free to join the group at any time. The ability of these students to make progress in their group-internal activities is always open to being preempted through intervention by the instructor.

In this interactional environment, students must become skilled at performing circumscribed roles within shifting participation frameworks. Specifically here, they need to master the art of breaking focus in order to attend to the teacher's talk whenever it occurs, and, as we discuss next, they must have the ability to reassert the group focus when it has been temporarily superseded by the teacher's talk.

Returning to the fuller segment we have been examining, represented in excerpt (7) earlier, we can document variation in the students' responses to Jensen's intervention (regarding the mazes). Delia, as we have noted, stops talking and visibly orients to interpreting Jensen's turn, gazing at him and then at Edith's sheet. Kira, on the other hand, takes the first pause at a possible point of completion in Jensen's turn (the pause after "fun," line 11) as an opportunity to object to what Jensen is saying. She counters his advice by stating that the group is not to the point of doing the mazes yet. Of the three students in this group, Kira speaks to the teacher with the least mitigation, objecting in a direct manner when his contributions are out of step with the activity the group has been constructing. Thus, just as she censures Edith for being out of order, Kira also shows no hesitation treating the teacher in essentially the same way. In response to the teacher's interruption, Kira's turns are directed first at correcting the teacher and then Edith. Through these actions, Kira asserts her own authority as one who can censure disorderly contributions by a student or by the teacher. Kira's interaction with the teacher and with the other students resonates with M. H. Goodwin's (1990, 1993) work on girls' dispute talk; Kira clearly does not fit the stereotype of the passive or conflict-avoiding girl.

In contrast, Delia tends to be conciliatory and adaptable in her talk and action. Delia displays this in her contributions following Kira's correction of the teacher and Edith. As a first response, Delia produces an affect display that seems aimed at diffusing the tension introduced by the teacher's contribution and Kira's reaction. This is seen in the smiling outbreath (first arrow) that she produces after watching Kira nod toward Edith and insist that the maze task is "after":

(10)

K: That's (0.6) after. ((**nodding toward E's sheet, gazing at E**))
(2.2)

⇒ D: shhsss ((**smiling outbreath**))
(0.3)

⇒ D: Okay, (0.4) It says obtain a plane mirror, (.) and touch
your right ear, (1.0) as you are looking into it.

At the completion of Kira's turn, Delia is looking at Kira and Edith; she continues to do so into the 2.2 sec pause. As she produces the "shhsss," her mouth moves into a smile formation and she begins to look down at her papers and mirror, the materials relevant to Procedure II. She calls the group to order with "Okay," and then begins to read aloud the directions that answer the question that Mr. Jensen interrupted with, "Which mirror are we supposed," the mirror being the "plane" one. Delia draws no further attention to the issue of the teacher's mistake, to Edith, or to the mazes; instead she focuses directly back on Procedure II. Delia is thus skillful in producing an affect display that seems to smooth the tension, and she is also artful in her strategy of redirecting the focus squarely back to the point it had reached before the disruption. Both Delia and Kira recognize the irrelevance of the teacher's contribution, a recognition that leads to their refocusing on their interrupted task.

After Mr. Jensen has contributed the collaborative extension shown in excerpt (9), Kira continues to be concerned with the fact that Mr. Jensen is wrong again about where the group is—his talk has revealed that he thinks they are on Procedure II, Item 8, when they are actually on Procedure II, Item 7. This is consequential because Procedure II, Item 7 does not ask the students to look at a partner, whereas the next item, Procedure II, Item 8, does (Appendix A). In his contribution, Mr. Jensen makes the assumption that the students are looking at their partners rather than just in the mirror when he says "And the reason that >the person< is looking, (.) You're looking at uh (.) Kira." The procedure items read as follows (also see Appendix A):

PROCEDURE II&IMAGE INTERPRETATION

7. OBTAIN A PLANE (FLAT) MIRROR AND TOUCH YOUR RIGHT EAR AS YOU ARE LOOKING INTO IT. ANSWER QUESTION 3 IN THE CONCLUSION SECTION.

8. FACE YOUR LAB PARTNER. HOLD THE MIRROR SO THAT YOU CAN SEE YOUR OWN IMAGE IN THE MIRROR AND YOUR PARTNER'S FACE ABOVE THE MIRROR. ASK YOUR LAB PARTNER TO TOUCH HIS/HER RIGHT EAR. LOOK AT YOUR IMAGE IN THE MIRROR AS YOU TOUCH YOUR RIGHT EAR. ANSWER QUESTION 4 IN THE CONCLUSION SECTION.

In order to get a sense of Edith's orientation to the teacher's presence in the group, and to get a further sample of Kira and Delia's orientations, we look at another fuller span of the talk:

(11)

- 1 D: If I touch my right e:ar, (0.4) I'm really like this,
 2 (.) So I'm touchin' my left ear.
 3 (.)
 4 T: And the reason >that the< person is looking, (.) You're
 5 looking at uh(.)Kira, (.) (cause) she's like an ima ge.
 6 E: [(But)]=
 7 (D): [(But see that's?)]
 8 E: =[that looks like] my right. ((**looking in mirror, lateral head movement**))
 9 (0.4)
 10 E: ((**quick smile at teacher**))
 11 (0.5)
 12 K: ↑It looks like my it wuh- It looks like [my right t-↑ ((**nodding at E**))
 13 T: [No.
 14 T: Nope [but thuh- that's your ima ge,
 15 D: [°No you touch your right ear,°
 16 T: Let's say she was here nuh-she you're looking at her.=
 18 K: =A(h)o::↑:
 19 T: [The image- that's he:r.= ((**T turns and walks away**))
 20 K: =Okay (I know now)=
 21 ?: =°Yeah°.
 22 (1.1)
 23 D: So I'm actually touchin' my left ear.=
 24 K: =NO JENSEN, THIS WAS A QUESTION FOR YOU.
 25 E: [I'm looking at you:::
 26 K: [>It don't say,< with a partner, it just say-

- 27 E: So it's your left, [A↑ohh:
 28 K: Obtain a [p- plane flat mirror and=
 29 E: [uh huh huh huh huh huh huh
 30 K: =touch your right ear as you are looking into it.
 31 (0.2)
 32 T: Yeah.
 33 K: It look like your ↑touching your right ea: [r↑=
 34 E: [BUT
 35 YOU (>SAY<) YOU'RE LOOKING AT HER. I -T'S LIKE YOU'RE
 ((leaning between T and K))
 36 LOOKING AT HER.
 37 T: |like an image.
 38 K: =Oh okay. o [kay.
 39 T: [She's the image.
 40 E: [Yeah.
 41 K: [o [kay. okay. °
 42 T: [I mean she's the same position as the image.
 43 (0.7) ((Teacher moves away))
 44 D: Yeah.
 45 (0.3)
 46 D: See so it's your left ear. ((to group members only))

To begin with, notice that Kira continues to put her energy into pointing out where the teacher's talk is out of line with what the students are focusing on. From lines 24–30, we see Kira first summoning the teacher back to the group to clear up the fact that he has given them an explanation for the wrong item. She calls out “NO JENSEN, THIS WAS A QUESTION FOR YOU:.” Here, Kira's “you” refers not to Jensen but the fact that the directions ask the individual students to look only at themselves in the mirrors, whereas Procedure II, Item 8, which the group has not gotten to yet, asks them to look at a partner (see the directions, earlier, and Appendix A).

Once Kira gets Mr. Jensen back to the laboratory table, she goes on to read the directions of the item they are on: “It don't say, with a partner, it just say- Obtain a p- plane flat mirror and touch your right ear as you are looking into it.” Kira again places a priority on being correct and competent with respect to the rules of the task and the actual focus of the group.

This attitude is quite different from that displayed by Edith (lines 6–10). By collaboratively extending Delia's turn, the teacher has been

agreeing with Delia's statement that the "left ear" is what she is really touching. Edith objects, saying "(But) that looks like my right." Although Edith has contradicted the teacher, when she meets his gaze, she immediately follows her contradiction with a quick, mitigating smile (see line 10 and Figure 7). Moments later, after Kira has called Mr. Jensen back to the table to convince him that he is wrong, Edith strongly aligns with the teacher (lines 34–40). Kira has been telling the teacher he is wrong about which item they are on, but meanwhile, Edith and Delia have engaged in a separate exchange. Edith has now shared the "discovery," and she proceeds to align with Mr. Jensen in "instructing" Kira. In lines 34–40, Edith leans forward over the laboratory table, cutting into the visual space between Mr. Jensen and Kira. As she points toward Delia with her mirror, she looks toward Kira and says loudly "YOU'RE LOOKING AT HER. IT'S LIKE YOU'RE LOOKING AT HER" (Figure 8). In saying this, Edith is partially repeating what Mr. Jensen said at line 16, "you're looking at her." Edith is intervening, verbally and physically, between Mr. Jensen and Kira on Mr. Jensen's side. Mr. Jensen collaborates with Edith's "like you're looking at her" by adding, in overlap, "like an image" (line 37). He then adjusts this to "She's the image" at line 39. In sum, Edith displays a role that is distinct from those of Kira and Delia. She contradicts the teacher but with immediate mitigation, and given the opportunity, she strongly aligns with the teacher in an instructing role.



FIGURE 7 Edith smiles toward Mr. Jensen.



FIGURE 8 Edith pointing toward Delia to co-instruct Kira.

Interestingly, Delia has every opportunity to align with the teacher and to coconstruct as well. After all, she is the one who was demonstrating her discovery just before the teacher came over and added to her turn (lines 1–2). Indeed, Delia seems especially willing to help the other group members think with her, which is just what she is doing with Edith while Kira calls Mr. Jensen back to the table (lines 23–27). In line 23, Delia is addressing Edith; Edith’s turns at lines 25 and 27 are responsive to Delia and show Edith’s coming to share the discovery that Delia has previously made. However, Delia primarily engages in this instructional activity when it is clear that she is aligning as a group member rather than as a coinstructor. In this regard, it is important to note that during the pause at line 22, just before Delia addresses Edith, the teacher has walked away. At that point, Delia starts to sum up the group’s understanding with “So I’m actually touchin’ my left ear.” As Delia finishes this turn, Kira calls out to Jensen, but Edith continues to attend to Delia and responds (lines 25 and 27) with “I’m looking at you” and “So it’s your left, Aohh:.” This is a case of *schisming* (Egbert, 1997): Edith and Delia are involved with a sequence that is separate from but simultaneous with the one between the teacher and Kira. This is not a case of Delia strongly aligning with the teacher. At the one point when Delia does join in with the teacher, line 15, she does so in a noticeably soft voice. What we see, then, is that Delia takes every opportunity to work with the other group members, but she does not jump in to align with the teacher to the

degree that Edith does. It is only after the teacher again moves away from the laboratory table that Delia returns to summing up what the group has learned, “See so it’s your left ear” (line 46).

With respect to the teacher’s talk, then, Kira displays the most concern for being acknowledged as correct in her understanding and her actions. Edith shows concern for displaying her understanding, but she is quick to demonstrate deference and positive affect toward the teacher, which is not characteristic of Kira in this segment (or elsewhere in the data). In the data we have examined here, we find that Edith is also ready to align with the teacher as a coinstructor. Delia, in contrast, seems most concerned with the emotional solidarity of the group, as shown in her affect display after Kira’s censuring of Edith. Delia also shows a different alignment with the teacher. Although she shows deference to him by abandoning her turn and becoming an attentive listener when the teacher interrupts her, Delia engages in instructional talk directed toward group members primarily when it is clear that she is doing this *with* the other group members rather than in strong alignment with the teacher. Thus, the intermittent interventions by the teacher and the margins of these interactions offer heightened moments for differing displays of deference, solidarity, and resistance (as in Kira’s assertions of her competence).

CONCLUSION

Although the analysis of laboratory group interaction is not the focus of Lemke’s (1990) groundbreaking investigation of talk in science classes, he did make reference to the laboratory task when he asserted that “[c]urriculum, of course, is much more than just the content that is taught. There are often nonverbal skills as well, and curriculum may also include activities better described by activity structures than by thematic patterns (e.g., in *laboratory work*)” (p. 94, italics added). Lemke also noted that “There are not many parallels to science laboratory work in the teaching of other core academic subjects” (p. 157). My goal in this study has been to begin to document the management of multiple roles and multiple resources among students in a span of such laboratory activity.

There are many potential ways to do the interactional work required for moving through a laboratory task such as the one we have observed; what I have examined is one group's way of managing the exigencies of such a task. Their skills involve the simultaneous and collaborative coordination of talk, gaze, gesture, reading, and the manipulation of objects. We have seen that their reading, linguistic reference, and other verbal and nonverbal actions are produced in a tightly interwoven manner. They use routine and expectable task-based talk and action to orient and guide their activities, thus making use of an accumulated understanding of the components of the shared order of science laboratory activity. The management of multiple resources in this laboratory bears resemblance to activities reported on by M. H. Goodwin (1995) and C. Goodwin (1996) involving tasks, objects, and talk in an airport operations room; there is also resonance with the use of objects and practices in joint—as well as rhetorically contested—categorization in archeological work sites and in courtroom interaction, as described by C. Goodwin (1994).

By looking closely at how reference and action are formulated at a particular moment of interaction, we begin to see the sorts of little understood skills required for seemingly mundane and routine group activities. Routine and mundane as this moment may at first appear, its seamless quality is built through complex interactive skills at what could be termed *cognition-in-interaction* (see Fassnacht, 1997; Schegloff, 1991). In documenting the anchoring role of written material, this analysis also provides a picture of a kind of literacy in action. In this moment of laboratory interaction, literacy is not a matter of longer and more sustained individual engagement with texts. What we see here is written material used as a resource, guide, and reference for speaking and acting. The written materials are inseparable from the ongoing action, and references within the spoken discourse are only interpretable with respect to their visible coordination with the written materials. Here again there is continuity with previous research in other settings. Houtkoop-Steenstra (1995) and Whalen (1995) have both pointed to ways in which standard written or computerized formats are adapted in interaction, though in those studies the interaction was dyadic and only one member of a pair had access to the preformatted text.

Observing Delia, Edith, and Kira has also offered us a perspective on the work of maintaining the jointness of a group laboratory activity while also dealing effectively with the authority of the instructor, a

privileged interlocutor. Teacher intervention is potentially misplaced and not guaranteed to be relevant to any current internal focus of a group; the teacher moves quickly from group to group, and does not always recognize which part of the shared task a particular group is in fact working on. Again, the jointness of the group work is not a given but is an accomplishment, one that is concertedly transformed at points where the teacher intervenes. We have seen that although these students are skillful in deferring to the teacher's actions, they are also skillful in rapidly reestablishing the group-internal structure subsequent to the teacher's intervention. They actively treat the teacher's interventions as privileged, but, at the same time, they are able to mark off an intervention when it is not relevant to the ongoing task at hand. They resist allowing the teacher's talk to take them too far afield from the point in the task that is their internally constructed focus.

In addition to the construction of jointness and the simultaneous flexibility in attending to teacher intervention, Edith, Kira, and Delia display individual identities and values, even in this short segment of interaction. Each student shows a different style of relating to the teacher's talk, forming different alignments with the teacher or with their own displayed needs to be socially acknowledged as competent and capable of producing relevant and appropriately on-task talk. In the case of Delia, we see a tendency to avoid an alignment option that is clearly available to her, that is, the option of aligning with Mr. Jensen as a coinstructor.

With respect to styles of speaking, the contrast between the ways that Kira and Delia respond to Mr. Jensen underscores the potential for variation in interactional strategies that girls may employ. As M. H. Goodwin (1990, 1993) has shown, girls are not, in fact, uniformly conciliatory or passive in their interactional strategies. Observations of the differing strategies employed by the students in this study suggest directions for further study of variation in girls' talk in educational contexts. The interactional practices documented here merit further exploration in other data to test both whether they are in any sense generic and also the manner in which group work strategies may vary across student communities.

One of my aims in this study has been to understand some of the interactional abilities students exhibit as they participate in a high school laboratory activity. I have paid particular attention to joint construction of task action and the coordination of multiple resources. The picture we get of the abilities of these students brings into focus components of competence that are only manifested as students interact simultaneously

with written materials and material objects, with each other, and with their instructor; such a picture should encourage us to question a notion of competence as only measurable in terms of the abilities of individual students. From this perspective, learning involves not only making conceptual connections but also, and crucially, making interactional connections, knowing how to coordinate action, and how to collaboratively construct learning activities.

The moment-to-moment practices of interaction documented in this study—skills in reference formulation and interpretation—should not be taken for granted. Clearly, students must develop and master these skills in order to succeed in subject matter courses such as this one. An understanding of the multifaceted social and cognitive nature of these activities is clearly relevant for professionals whose job it is to design and implement laboratory tasks. Once laboratory activities are subjected to this sort of close empirical analysis, the interactional aspects of these tasks can be more explicitly addressed by educational researchers and practitioners. In this study, students exhibit specific skills for constructing jointness of action, such as voicing shared or accessible information, providing verbal and nonverbal feedback as to where they are in the shared process, and visibly and hearably marking continuation or suspension of progress in the implicit order of laboratory activity, an order that they have learned and developed through repeated involvement in such tasks in this class as well as others. Educators can only factor in these interactional components of student skill and content knowledge if such aspects of what constitutes knowledge have been documented through the close analysis of actual situated practices.

Levinson (1992) acknowledged that although one goal of teaching is to organize and transfer knowledge (“the gnostic function”), another is “to impart abilities, or knowledge of procedures” (p. 93). Through the examination of a span of laboratory interaction, an activity that is central to science education as well as to other focused setting for collaborative action, my hope is that this study directs our attention to the interactive “process” end of the skills continuum. The collaborative activity involving Delia, Kira, Edith, and Mr. Jensen during some unremarkable moments in a laboratory task offers us a glimpse of the interactional requirements of a high school physics class in which the process—the task—is intended to serve as a matrix for discovery of subject matter knowledge. I submit that these complex interactional practices are inseparable from what should be understood as the content of science—a body of lived knowledge.

NOTES

- 1 By way of acknowledging the limitations of the type of microanalysis that this study represents, let me note two areas of interest for sociolinguists and educators to which the present study can contribute only indirectly. First, although the students in this laboratory activity are representatives of ethnic minorities (one is African American and two are Latina), and although they live in an inner-city community, I cannot make any generalizations about the relations of these facts and what the students do in this particular moment of interaction. However, it is my hope that the careful documentation of interactional practices that I present here will provide input into comparative studies of variation in such practices.
 Second, scholars of discourse and education observe that students can learn skills at “pulling off” being a student (J. Gee, personal communication, April 15, 1998), “forms of linguistic knowledge and behaviors needed to display right answers” (Gutiérrez, 1995, p. 22), but that such skills do not necessarily lead to learning in a more profound and valuable sense. I argue that it is by no means a trivial analytic task to judge the degree to which the students in this study are experiencing their interaction as merely a performance of what is expected of them as opposed to a more profound and consequential learning activity. What does seem clear is that these students display skills at collaborative construction and the simultaneous manipulation of objects, tasks, and frameworks of participation, and that skills such as these, and surely others as well, form a foundation or matrix for learning—a *scaffold* that, in a nontypical sense of the term, operates without direct teacher input. The complex management of resources and social actions is part of learning, a part of learning that should be carefully documented rather than taken for granted.
- 2 My analyses are critically dependent on the fieldwork of my colleague Jane Zuengler, who has visited the research site twice a week during the past 3 semesters (beginning in Fall 1996).
- 3 The “one-step-at-a-time” orientation as well as the concern for task completion was brought to my attention by an anonymous reviewer.
- 4 Note that in another laboratory interaction that I am analyzing, Kira also takes a similar leadership role, calling out “next” as a way of moving the group work forward.
- 5 I thank Chris Fassnacht for drawing my attention to the reflexive relation between the talk, the agenda, and the written materials at this moment in the activity.
- 6 See Levinson (1992) for a critique of Searle’s account of “exam” questions.
- 7 See Duranti (1997, pp. 294–319) for a review of the notion of participation frameworks in discourse studies, and see O’Conner and Michaels (1996, pp. 67–70) for an insightful discussion of the significance of such frameworks of participation for the microanalysis of classroom interaction.
- 8 In this laboratory, as in others, clause combining is also a resource for enacting collaboration (Lerner, 1991). Delia can stop here, midsentence, and use the incomplete unit to hold the progress and also to invite collaboration.

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APPENDIX A

Procedure Sheet (Yellow)

THE IMAGE IN A PLANE MIRROR



INTRODUCTION:

LIGHT THAT BOUNCES OFF AN OBJECT IS SAID TO BE **REFLECTED**. A PIECE OF PAPER SCATTERS LIGHT IN ALL DIRECTIONS. HOWEVER, BECAUSE A MIRROR HAS A SMOOTH SURFACE, IT REFLECTS THE LIGHT EVENLY. TODAY, MOST MIRRORS ARE MADE BY DEPOSITING A THIN LAYER OF SILVER ON A SHEET OF GLASS. THE SILVER SIDE IS PROTECTED FROM TARNISHING BY THE GLASS. PLANE (FLAT) MIRRORS PRODUCE IMAGES VERY SIMILAR TO THE OBJECTS THEY REFLECT. DIFFERENCES, HOWEVER, DO EXIST.

PURPOSE:

IN THIS INVESTIGATION, YOU WILL MEASURE AND COMPARE THE DISTANCE OF AN OBJECT FROM A REFLECTIVE PIECE OF GLASS AND HOW FAR ITS IMAGE APPEARS TO BE FROM THE GLASS.

AFTER COMPLETING THIS INVESTIGATION, YOU WILL ALSO BE ABLE TO DESCRIBE AND EXPLAIN HOW AN OBJECT AND ITS REFLECTED IMAGE ARE DIFFERENT.

PROCEDURE: PART I—HOW FAR IS AN IMAGE BEHIND A MIRROR?

1. SLIDE A GLASS PLATE INTO A WOODEN HOLDER. THIS PIECE OF GLASS CAN REFLECT LIGHT LIKE A MIRROR, EVEN THOUGH IT HAS NO SILVER COATING ON THE BACK. THE IMAGE, HOWEVER, DOES NOT SHOW UP AS WELL.
2. PLACE A SMALL CANDLE 20 CENTIMETERS IN FRONT OF A GLASS PLATE. THIS CANDLE IS THE "OBJECT" FOR THIS INVESTIGATION. THE 20 CENTIMETERS SHOULD BE MEASURED FROM THE **CENTER** OF THE CANDLE TO THE **CENTER** OF THE GLASS PLATE. THIS DISTANCE HAS BEEN RECORDED IN THE DATA TABLE FOUND IN THE CONCLUSION SECTION.
3. WHEN ALL MEASUREMENTS HAVE BEEN MADE, LIGHT THE CANDLE AND LOOK STRAIGHT INTO THE GLASS PLATE. TRY TO FIND THE **IMAGE** OF THE CANDLE **BEHIND** THE GLASS PLATE.
4. NOW, PLACE AN UNLIT CANDLE OF THE SAME SIZE ON THE OTHER SIDE OF THE GLASS PLATE. MOVE THE UNLIT CANDLE UNTIL THE IMAGE OF THE FLAME APPEARS TO FALL EXACTLY ON THE UNLIT WICK.

APPENDIX B

Conclusions Sheet (White)



NAME _____

DATE _____ HOUR _____

THE IMAGE IN A PLANE MIRROR— CONCLUSIONS

DATA TABLE

MEASUREMENTS	OBJECT DISTANCE TO GLASS PLATE (CENTIMETERS)	IMAGE DISTANCE TO GLASS PLATE (CENTIMETERS)
MEASUREMENT #1	20 CENTIMETERS	
MEASUREMENT #2	15 CENTIMETERS	

1. HOW DOES THE IMAGE DISTANCE COMPARE TO THE OBJECT DISTANCE IN MEASUREMENT #1?
 - A. THE IMAGE DISTANCE IS GREATER THAN THE OBJECT DISTANCE.
 - B. THE IMAGE DISTANCE IS LESS THAN THE OBJECT DISTANCE.
 - C. THE DISTANCES ARE APPROXIMATELY THE SAME.

2. HOW DOES THE IMAGE DISTANCE COMPARE TO THE OBJECT DISTANCE IN MEASUREMENT #2?
 - A. THE IMAGE DISTANCE IS GREATER THAN THE OBJECT DISTANCE.
 - B. THE IMAGE DISTANCE IS LESS THAN THE OBJECT DISTANCE.
 - C. THE DISTANCES ARE APPROXIMATELY THE SAME.

3. WHICH EAR IS YOUR IMAGE TOUCHING? A. LEFT B. RIGHT

4. COMPARE YOUR IMAGE WITH THAT OF YOUR PARTNER.

5. WRITE THE WORD "MIRROR" AS IT APPEARS IN THE MIRROR.

6. DESCRIBE WHAT YOU SEE IN THE MIRROR AFTER FOLLOWING STEP 11 IN THE PROCEDURE SECTION.

